Observations on the foraging behaviour of the introduced honeybee *Apis mellifera* L. (Hymenoptera: Apidae) on the saltmarsh plant *Sarcocornia quinqueflora* at Sydney Olympic Park

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ABSTRACT

The foraging behaviour of the introduced honey bee *Apis mellifera* on the saltmarsh plant *Sarcocornia quinqueflora* was observed over three days at Sydney Olympic Park in February 2007. Within an observation area of approximately 3m x 3m, the number of flowering and non-flowering branches of *S. quinqueflora* visited by bees and an estimated duration of each visit was recorded. The foraging behaviour of 63 bees was observed on branches within the observation area with a significantly greater mean number of flowering branches (3.68±1.86) visited compared to non-flowering branches (1.58±1.72) per bee. The mean visitation time to flowering branches by each bee (2.11±0.58 sec per branch) was significantly greater than that of non-flowering branches (1.29±0.41 sec). The majority of bees collected had pollen from *S. quinqueflora* on all parts of their body, as well as within the corbicula. Combined with the disturbance of pollen, that may assist wind dispersal, the transfer of pollen between the saltmarsh plants by *A. mellifera* may play a role in their pollination but further research is required.

Key words: honey bee, *Apis mellifera, Sarcocornia quinqueflora,* saltmarsh

Introduction

In coastal NSW, saltmarsh communities are typically dominated by salt tolerant plants that are intermittently inundated by spring tides and provide important habitats for plant and animal species (Keith 2004, Laegdsgaard 2006). The pressures of urban development and spread of mangroves has reduced and degraded the cover of saltmarsh (Saintilan and Williams 2000). As well as protecting existing saltmarsh, various wetland construction and rehabilitation projects are being undertaken in many places, and a greater understanding of the ecological and biological processes in saltmarsh communities is required (Zedler 2001).

One of the most common plants associated with saltmarshes is *Sarcocornia quinqueflora* (Bunge ex Ungen-Sternberg) A.J.Scott (Chenopodiaceae), commonly known as samphire, glasswort or bead weed, a succulent herb with clusters of yellow flowers occurring on the branches during summer (Beadle *et al.* 1982, Robinson 1991, Johns 2006). Seeds of this plants are thought to be distributed by tides (Laegdsgaard 2006) but little is known of the pollination process in *S. quinqueflora* although, like many saltmarsh plants, it has been assumed that wind and insects are likely to play an important role (Adam 1990). Bees have been observed collecting pollen from saltmarsh plants, including the bumble bee *Bombus terrestris occidentalis* Grne in Canada (Pojar 1973), and the European Honey bee *Apis mellifera* (Linnaeus) on the NSW south coast (Adam *et al.* 1987). Since the reduced flowers of *S. quinqueflora* do not produce nectar, Adam *et al.* (1987) proposed that *A. mellifera* foraged for pollen as a source of protein and may be acting as a pollinator of *S. quinqueflora* through the physical transfer of pollen between plants.

Originally introduced to Australia in 1822, to assist crop pollination and honey production (Dollin *et al.* 2000), *A. mellifera* is widely distributed and has been associated with adverse impacts on native flora and fauna (Paton 1993, Oldroyd *et al.* 1997). However, despite reports of adverse impacts on native bees, there is some uncertainty as to the extent of this impact in the complex Australian ecosystem (Paini 2004), and honeybees have been shown to assist the pollination of some native plants, including species adapted to bird or marsupial pollinators (Vaughton 1992).

The aims of this investigation were to expand and quantify the observations of Adam *et al.* (1987) within the saltmarsh of Sydney Olympic Park by recording the visitation rate of *A. mellifera* to flowering and non-flowering branches of *S. quinqueflora*.

Methods

The study site

Sydney Olympic Park is located in western Sydney on the southern side of the Parramatta River adjoining Homebush Bay. The area contains one of the largest areas of tidally influenced saltmarsh in the Sydney region and this study was conducted in a small area of the saltmarsh within the Wanngal Wetlands (Newington Nature Reserve).

The saltmarsh is dominated by four plant species, *S. quinqueflora*, *Suaeda australis* (R. Brown) Moquin-Tandon, *Sporobolus virginicus* (Linnaeus) Kunth, and *Triglochia striata* Ruiz and Pavon. The relative abundance of each species varies across the site as a result of elevation and flooding frequency (Adam 1996). The saltmarsh is bordered on one side by a mangrove forest (dominated by *Avicennia marina* (Forsskål)) Vierhapper and nearby is extensive woodland of *Casuarina glauca* Sieber ex Sprengal.

Bee surveys

This opportunistic study followed an incidental observation of *A. mellifera* activity on the saltmarsh in early February 2007, and was designed to quantify foraging behaviour on *S. quinqueflora*. Bee surveys were conducted within an area of saltmarsh dominated by *S. quinqueflora*. Surveys were conducted on three days (17, 19 and 20 February 2007). Bee foraging was observed over 30 minutes (approximately 0900-0930) with the number of flowering and non-flowering branches visited by each bee within a quadrat of 3m x 3m recorded. Bees were observed directly by the researcher from no more than 3m away. The time spent on each branch by each bee was estimated in seconds.

Bee sampling

A sweep net was used to collect five bees on each day. Bees were anaesthetised using carbon dioxide (from dry ice) and returned to the laboratory to confirm identification and inspect the bees for the presence of pollen.

Climatic factors

Temperature and relative humidity during the observations were taken from the 9am meteorological data provided by the Bureau of Meteorology for the Sydney Olympic Park meteorological station (station number 066195).

Statistical analysis

Mean branch visits and mean visitation times of bees on flowering and non-flowering branches were compared using one-way analysis of variance (ANOVA).

Results

Average temperature during the observations was 23.1°C (range = 22.6 - 23.5°C) and average relative humidity was 72.7% (range = 70 - 74%). No rainfall was recorded and no tidal inundation of the saltmarsh occurred during any of the sampling occasions.

Bees were active on the saltmarsh on all three sampling occasions, and the foraging behaviour of a total of 63 bees was recorded, although it was not possible to determine if some bees were re-entering the survey area during the observation period. All bees collected were identified as *A. mellifera* and no other bee species was either observed or collected.

The bees visited more flowering branches than non-flowering branches on each morning (Figure 1). The overall average number of flowering branch visits by bees was 3.74 ± 2.04, significantly greater ($F_{1,106} = 17.31$, $P < 0.05$) than the overall average number of visits to non-flowering branches of 1.48 ± 1.72.

The mean period of visitation to flowering branches was greater than the time spent on non-flowering branches on each morning (Figure 2). The overall mean visitation period on flowering branches was 2.12 ± 0.64 seconds, significantly greater ($F_{1,106} = 52.04$, $P < 0.05$) than the visitation period on non-flowering branches of 1.32 ± 0.44 seconds. It is important to note that while

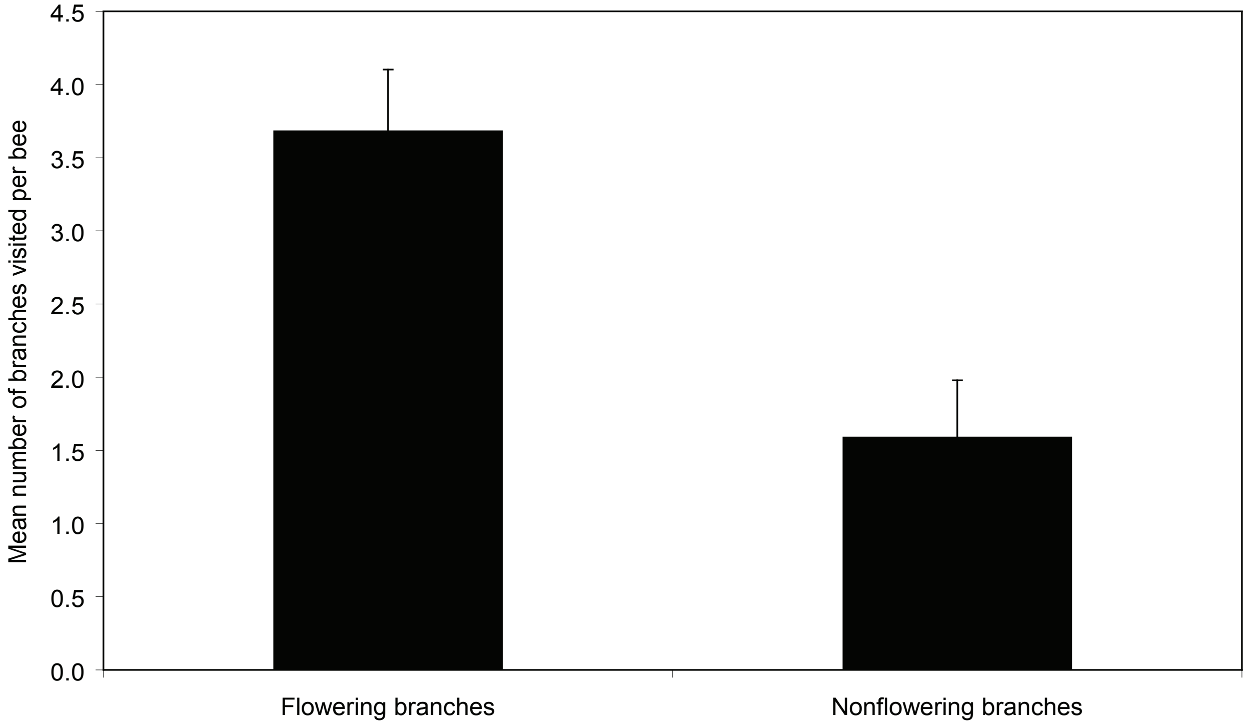

Figure 1. Mean number of visits per bee to flowering and non-flowering branches of the saltmarsh plant *Sarcocornia quinqueflora* by the introduced honey bee *Apis mellifera* at Sydney Olympic Park, February 2007.

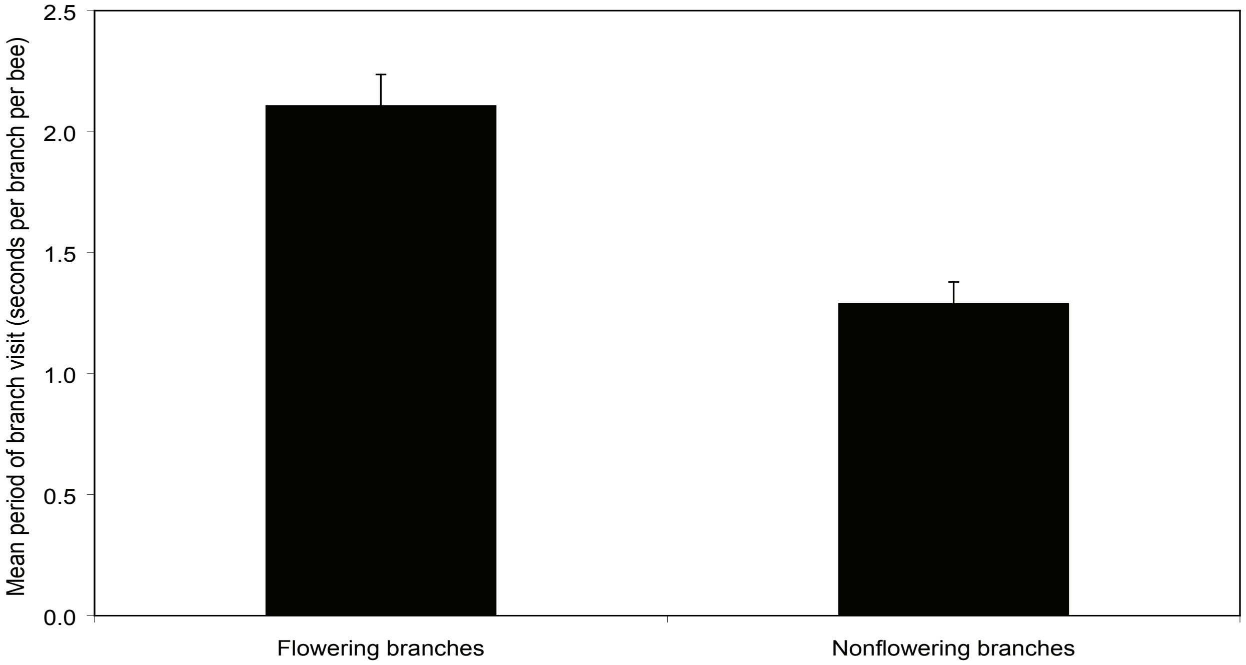

Figure 2. Mean individual visitation periods on flowering and non-flowering branches of the saltmarsh plant *Sarcocornia quinqueflora* by the introduced honey bee *Apis mellifera* at Sydney Olympic Park, February 2007.

the minimum recorded visitation time was 1 second, many bees immediately left non-flowering branches after landing and, as a result, the mean visitation times may be slightly over-estimated in the data.

Bees were observed foraging up and down flowering branches with pollen released in small 'clouds' that were visible drifting away from the bee and branch. In the process, bees become covered in pollen, and all but two of the bees collected had substantial amounts of pollen within the corbicula and elsewhere on their bodies (including thorax, abdomen, head and legs).

Discussion

The results of this brief opportunistic investigation confirm the earlier observations of Adam *et al.* (1987) that *A. mellifera* forages on *S. quinqueflora* and collects pollen from flowering branches. The results indicate that bees are specifically foraging on the pollen of *S. quinqueflora* and, as the foraging behaviour of *A. mellifera* may be influenced by pollen (Cook *et al.* 2003), may indicate that flowering *S. quinqueflora* represents a locally important source of protein. Given the number of branches visited by bees and the large amount of pollen present on the bee's body, combined with the disturbance of pollen during foraging that may enhance wind dispersal, *A. mellifera* may well play an important role in the pollination of *S. quinqueflora.*

Honeybees may also be having an adverse impact on pollination of native plants by removing pollen before other, potentially more effective pollinators, have an opportunity to visit flowers (Paton 1993). In the case of *S. quinqueflora*, the removal and/or disturbance of pollen may reduce the quantity available for preferred pollination mechanisms. The abundance of pollen across the body of the bees, and the rapid visitation to many flowering stems in quick succession without major grooming activity, may assist pollination, but the disturbance of pollen and removal from stems early in the morning before wind strength increases in the afternoon may reduce the potential quantity and distance of dispersal.

In the absence of investigations into the role of native pollinators, and the pollination process in general for *S. quinqueflora,* it is not possible to make a definitive conclusion regarding the relationship between the frequency and duration of visits of *A. mellifera* to *S. quinqueflora* and either the positive or negative impact on pollination effectiveness. Studies have shown that pollen removal by frequently visiting *A. mellifera* can decrease the pollination effectiveness of other pollinators (Paton 1993). At least 20 species of insects, including flies, bees, wasps, moths and ants, were observed visiting the saltmarsh plant *Frankenia pauciflora* var. *gunnii* in field studies in a saltmarsh in South Australia and that these insects may be locally important for pollen transfer (Mackay and Whalen 2009). Celebrezze and Paton (2004) observed that for the flowering shrub *Brachyloma ericoides,* despite *A. mellifera* visiting flowers, and moving between plants, more frequently, significantly lower fruit set was recorded when compared to fruit set in the presence of bird pollinators, possibly due to differences in the effectiveness of the two pollinators or interference by *A. mellifera* on the effectiveness of bird pollination. In the absence of experimental studies into the relative importance of insects (or vertebrates) as pollinators of saltmarsh plants, it is difficult to determine the significance of implications of this study and further research is required.

Restoration of coastal saltmarsh is important for the conservation of this habitat but successful restoration requires an understanding of complex ecological factors (Laegdsgaard 2006). In Australia, efforts to rehabilitated areas of *S. quinqueflora* saltmarsh found that recovery was slow but varied markedly depending on local conditions, with lower marsh areas recovering more quickly than higher marsh (Laegdsgaard 2002). Factors such as soil quality, tidal inundation and degree of isolation from natural saltmarsh are important factors in determining recovery of rehabilitated areas (Laegdsgaard 2006), but the importance of pollination in rehabilitation is rarely mentioned. As such, it is difficult to assess the importance of insect pollinators for, or the role native and introduced bees may potentially play in, the rehabilitation of degraded and/or transplanted stands of *S. quinqueflora*. Further investigations are required to determine the significance of bees and other insects in the pollination process of *S. quinqueflora* and other saltmarsh plants in NSW.

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